AD A118079

unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report ONR No.8	2. GOVT ACCESSION NO. AD-A118079	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Information Load Stress, Risk Taking and Physiological Responsivity in a Visual-Motor Task		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Siegfried Streufert, Ph.D., Susan C. Streufert, Ph.D. and Ann L. Denson, M.A.		8. CONTRACT OR GRANT NUMBER(s) N00014-80-C-0581
9. PERFORMING ORGANIZATION NAME AND ADDRESS PA. State University, M.S. Hershey Med. Ctr. Department of Behavioral Science 500 University Drive, Hershey, PA 17033		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 170-909
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research Code 442 Quincy Street Arlington, VA 22217		12. REPORT DATE May 1982
		13. NUMBER OF PAGES 25
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

arousal, blood pressure, computers, heart rate, information, load, performance, risk, risk taking, stress, visual motor tasks

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The effects of four levels of information load on physiological responsivity (blood pressure and heart rate) and on risk taking were analyzed and compared to previous results concerning the effects of load on performance. Twenty-five adults participated in a hand-eye coordination task of moderate complexity. The task was designed to permit strategic responding, risk taking and retaliatory behavior. Risk taking was measured as the degree to which subjects acted to increase the probability of a major loss in the face of potential

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

82 08 10 011

DTIC FILE COPY

unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

minor gains.

It is argued that an expected stress effect on risk taking and performance can be defended only if load would result in elevated arousal with risk taking and with decreasing levels of performance. It was found that participation in the present task was associated with some degree of arousal and that persons with greater (diastolic) arousal tended to take greater risks. Load affected risk taking but was not related to physiological responsivity. The potential that load as a stressor functions as a cognitive modifier of performance, and does not represent a precursor of strain (and stress), is considered. Suggestions for future research are made.

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Information Load Stress, Risk Taking and Physiological Responsivity in a Visual-Motor Task

Siegfried Streufert, Susan C. Streufert and
Ann L. Denson

The Pennsylvania State University
College of Medicine
Hershey, PA

Many human activities are associated with some degree of risk. The level of risk may be so small that it is typically ignored; it may be sufficiently large to cause concern but may produce little evasive action, or it may be great enough to produce significant changes in human physiological and/or behavioral responses. Responses to risks imply that the person involved is aware of a risk produced by the environment or by another person, or one that he or she has created personally. In the latter case, risk taking may be produced by a conscious decision to engage in risky behavior which may have short-range consequences for the task in which the individual engages and it may have long-range consequences for the individual's health and his or her future capacity to function.

It is not surprising that considerable research on risk taking has been reported in the literature. Most of the approaches to human risk taking are covered in a number of extensive reviews of the field (e.g., Lamm, Myers and Ochsmann, 1976; Payne, 1973; Pruitt, 1971a, 1971b; Streufert, Castore, Nogami and Streufert, 1979; Vlek and Stallen, 1980). The reader of these reviews will note that the majority of data on human risk taking have been collected in imaginary (artificial) paper and pencil tasks that may not be applicable to many "real world" settings involving potential risk. In part, the trend toward questionnaires has been dictated by the limitations inherent in potential risky situations. If behavior might result in injury or loss, it can hardly be employed in research settings. Nonetheless, investigations about the reliability and validity of various research techniques (c.f. Fromkin and Streufert, 1976) have shown that role playing and related paper and pencil efforts produce less than desirable data.

Researchers approaching the problem of risk taking from an applied vantage point have used different techniques (e.g., Woo and Castore, 1980), but have tended to focus on specific issues which may or may not generalize. For example, efforts concerned with risk taking in decisions related to nuclear power have investigated low risk/high consequence problems which probably do not occur in a similar fashion very often. Scores of studies have been reported on human behavior in motor vehicles. Again, generalization of this work has frequently been unsuccessful. Other efforts, often employing simulation techniques, have focused on military risk taking, most often in combat settings. Whether the findings from such efforts can be applied to executive decision making, for example or even to peacetime military (e.g., installation management) decision making, remains in question.

To summarize: a generally applicable approach to risk taking behavior appears still to be absent. While some models of risk taking have been proposed (e.g., portfolio theory or weighted utility theory), they have typically been restricted to gaming settings where clearly defined alternative potential decisions with specified risk levels are available. Utilization of such models in applied settings have frequently failed to support the models (e.g., Lehner, 1980) or have been limited by confounds generated by characteristics of the subjects (e.g., Schoemaker, 1979). Yet other models have failed to account for the complex dimensionality of human risk taking which often exceeds the simple "rationality" assumptions made by a number of models (c.f., Milburn and Billings, 1976). In the absence of sufficiently complex models and sufficiently broadly applicable theories, we need to learn more about the underlying tendencies to accept or refuse, to seek or to avoid risks under specific environmental conditions. In addition, we need to explore in some detail the effects of stressors on risk taking propensity and risk incidence.

Environmental Stressors and Risk Taking

Stress effects (e.g., the effect of information load, effects of time restrictions, etc.), task effects (e.g., skill required to perform a task, secondary outcomes of previous performance, etc.), and effects of specific work environments (e.g., monotony) have not been systematically related to risk taking. Nonetheless, some relevant research has been reported. For example, Ben-Zur and Breznitz (1981) have reported data indicating that time pressure may reduce risky behavior. In the research of these authors, decision makers placed under time pressure tended to focus on negative events and eliminated positive events (which could have given rise to additional risky behaviors) from major consideration. Streufert and Streufert (1970) obtained somewhat similar data in a complex simulation: decision makers exposed to stress tended to restrict their efforts to single decision making dimensions. Data of this nature should not be interpreted as implying that stress would be likely to reduce risky behavior. Rather, stress would be likely to shift the focus of decisions from a more multidimensional toward a more unidimensional orientation (c.f. Streufert, 1970). The degree to which risk taking can be expected would then depend on the risk potential of the remaining decision dimension. If respondent behavior on such a dimension (c.f. Streufert, Driver and Haun, 1967) would likely be risky, we might expect higher levels of risk taking under stress. If, on the other hand, respondent behavior would exclude or diminish risky actions, then effective risk taking would be reduced in the presence of stressors. On the average (and in the majority of decision making and in many problem-solving tasks), strategic behaviors which consider the potential outcomes of actions (a multidimensional process) would likely be eliminated under stress. Consequently, a concern about whether or not an action may be unreasonably risky would only have limited effects on the probability that this action would be taken (as long as decision making or problem solving remains respondent). In other words, for tasks where decisions can be risky, [illegible]., tasks where behaviors may produce losses, increased risk taking with stress may be expected. However, these risky actions would, as suggested by the research of Ben-Zur and Breznitz (1981) and Streufert and Streufert (1970), be based on a single decision-making or problem-solving dimension.

Research has also shown that the level of risky decision making in which people are willing to engage depends, of course, on their individual perceptions of the task environment. It appears that those subjects who engage in greater risks are often less aware of the degree of the risk involved (e.g., Mackova, 1979). To some degree, this outcome can be manipulated by others: task instructions emphasizing the rewards that may be obtained from risky behavior often result in riskier courses of action than task instructions which emphasize the penalties associated with potential risk taking, even if there are no real differences in the task at hand (Dickson, 1978). Similarly, describing a task as involving potential loss vs. describing the same task as involving potential gain can result in differential levels of risky decision making (Tversky and Kahneman, 1981).

The task itself can also affect risk taking. Relative risk preference often increases when less is at stake (Coombs, Donnel and Kirk, 1978) and when potential negative outcomes of a risky action are remote in time (Jones and Johnson, 1973). Risk taking increases when the task is perceived as based on skill rather than chance (Lupfer and Jones, 1971) and when social support for potential risky actions is available. Fatigue, leading to a desire to avoid effort, can produce risk taking (Barth, Holding and Stamford, 1976) and a loss following a previous *commitment of resources* often increases risky investment of additional resources ("throwing good money after bad") when a decision maker feels personally responsible for the previous commitment (Staw, 1976).

Risk and Physiological Response

A risk would not be a risk if it were not potentially associated with some form and some degree of loss, i.e., a potentially unpleasant event or outcome. To the degree to which this outcome has importance to a decision maker or problem solver its occurrence would be punishing and, consequently, would be likely to generate some level of specific or generalized physiological arousal. In other words, one can argue that arousal might be associated with risk taking. This is not to say that all risk taking by all persons must be reflected in physiological changes: (1) risk taking may not result in loss if the risk taker is highly skilled in the task at hand (c.f. the perception of risk takers as more competent as discussed by Jellison and Riskind, 1972), and (2) the risk taker may simply not believe that a loss is a potential outcome. Nonetheless, the majority of people would be aware that a risky action may result in some undesirable consequence. If past reinforcement history has provided some experience with such an undesirable outcome (or a similar event), then anticipatory arousal associated with a risky decision or action would not be surprising (always assuming that the undesirable outcome would be a rapid consequence of the risky action).

Some experimental evidence of arousal associated with risk taking has been reported (e.g., Roth, Guhlman and Girbardt, 1976). Other researchers, however, have failed to substantiate such a relationship. For example, Roscoe (1978) was unable to relate heart rate increases to risky actions by test pilots. It appears that modifier variables are involved in the arousal to risk relationship.

The relationship between various stressor variables and physiological arousal has been clearly established (e.g., the work of Glass, Krakoff, Finkelman, Snow, Contrada, Kehoe, Mannucci, Isecke, Collins, Hilton and Elting, 1980, has demonstrated the effects of overload on increased blood pressure and epinephrine levels; Patkai, 1971, has found elevated catecholamines during games of chance; and Johansson, Aronsson and Lindstrom, 1978, have related work load and monotony to increased secretion of epinephrine and non-epinephrine). In other words, the stress to arousal relationship appears to be reliable and general. If we assume that risky decision making or the awareness of risky decision making implies some stress for the decision maker, then some arousal should be expected. For that matter, the potential relationship between stress (e.g., stress produced by overload) and risk taking may well be mediated or at least clarified by the measurement of accompanying arousal levels. This research was designed to explore the stress-risk-arousal relationship.

METHOD

Twenty-five adult male paid volunteers with a median age of 49.3 (range 23 to 71) participated as individuals in a hand-eye coordination task presented in the form of a video game. Upon arrival at the laboratory, each subject was individually briefed about forthcoming events and his signature on a consent form was obtained. He was then presented with the task.

The Task

A video game task, not unlike Pac Man, was specifically developed for this research.* The game utilizes a series of concentric passageways filled with a number of squares which the subject is to scoop up with a horseshoe-shaped object which he is able to move by operating a handle on a small box placed on the subject's desk. The matrix of passageways is presented in Figure 1. The subject begins with a score of five points. Scooping up one square adds five points to the subject's score. Moving through one unit of empty space between the squares subtracts one point from the score. In other words, a continuous movement through spaces filled with squares would add 5-1=4 points for each square collected. Moving through spaces where no

*The task was generated by an Apple II Plus Computer utilizing a floppy disk program developed specifically for this research by the Wise Owl Workshop.

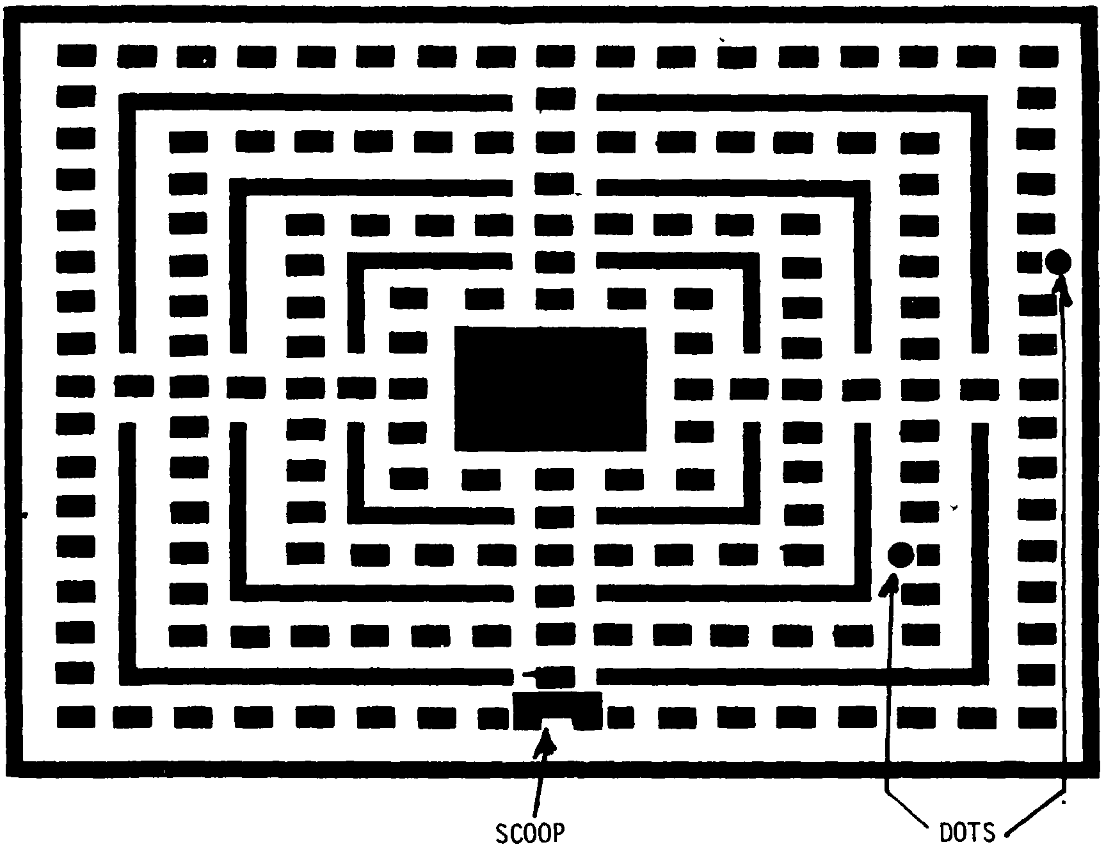

FIG. 1. TASK MATRIX

squares are present would subtract one point for each empty space, including those spaces occupied previously by squares. In other words, to obtain as high a score as possible, it is useful to avoid moving through blank spaces, i.e., to move so that as many squares as possible can be picked up in one continuous series of moves. Movement is possible only through passageways. Movement across solid lines is not possible.

In addition to the squares, from one to eight dots (differently colored) can appear in the matrix shown in Figure 1. The dots move randomly along the passageways of the matrix, reversing their direction (again randomly) from time to time. The dots are to be avoided: colliding with them is considered an error, costing the subject 100 points for each collision. A collision removes the dot to a different random position in the matrix so that a second collision due to the same error does not occur.

The computer program permits the experimenter to systematically vary a number of characteristics which apply during any one task period. The characteristics which can be modified are: (1) the speed of movement for both the subject's scoop and the dots which the subject is to avoid. Speed can be increased or decreased in four equal interval steps; (2) the number of dots on the screen. The experimenter can choose from one to ten dots with which the subject could potentially (and repeatedly) collide; (3) throughout the task period, a score representing an experimenter-selected value indicating either the average score obtained by other subjects on their first try or (optionally) the highest score obtained by any subject. This may be displayed on the bottom of the screen. In addition, the experimenter is free to select the number of task periods which are to be employed in the research effort. Each period lasts until the subject has successfully scooped up all the squares from the matrix on the video screen. The subject's current score is continuously displayed at the bottom of the screen. As stated before, the score starts at +5 and increases as more and more squares are captured. It decreases with collisions with dots and with movement through blank spaces. The score may become a negative value if the subject moves through blank spaces 2.5 times more often than squares are captured or if the subject repeatedly loses blocks of 100 points by collision with dots.

Instructions to Subjects

Subjects are instructed via video tape in detail about the operation of the task. They are reminded to avoid collisions with white dots. They are also told about the loss of points created by moving through blank spaces. They are further asked to try to do as well as possible, to avoid letting scores drop below zero, and to try hard again during the next task period if they are not as successful as they might wish during a previous period. While the subjects are presented with the consequences of failing to use strategy, they are not told what strategy should be used to obtain maximal scores. Instructions are moderately challenging, and can be considered somewhat below the challenge and competition level induced by Dembroski, MacDougall, Shields, Petitto and Lushene (1978). The level of challenge and competition selected for these instructions was based on work environments rather than experimental environments. The subjects are told to expect different speed levels and different numbers of dots to be avoided from one game period to another. The actual number of periods that will be played is not specified in advance.

Load Manipulation

Subjects were initially given a practice try to familiarize themselves with the task and eliminate or decrease the potential effects of previous experiences with video games. For the practice task, speed was held at level 1 (low). Only one dot was presented in the matrix. After completing this task period (and after all other subsequent periods), subjects responded to a number of seven-point scales (manipulation checks). After completing the scales, a subject was asked whether he was ready to try the task again. All subjects responded positively in all cases.

All subjects participated in four task periods following the practice period. The number of dots, representing the load manipulation, was systematically varied for these four periods. Either 2, 4, 6 or 8 dots were placed into the matrix. From a number of random sequences for the load manipulation, 25 were chosen (via a counterbalancing procedure) to assure that specific load levels would not occur inordinately often at any sequence position. Speed for all four task periods was held at level 2 (moderate). Subjects were not aware of what their next load level would be until the matrix with the relevant number of dots appeared on their screen at the beginning of a task period.

A read-out at the bottom of the video-screen informed subjects during the first (practice) period that the average score obtained by other subjects during their first try had been 435. That score level was rather easy to achieve and was surpassed by all but two of the subjects in this research. For the following four task periods, the subscript on the screen indicated that the highest score obtained by any subject so far had been 898. None of the subjects achieved or surpassed that score.

The performance of all subjects in response to tasks at all load levels was video-taped for later analysis. Data were based on subjects' scores for the four periods following the practice period.

Measurement of Risk Taking

Measurement of risk taking must be concerned with actions which increase or decrease the probability of a loss. For the purpose of the present task, subjects had been instructed that any collision of their scoop with a dot was to be avoided because of the cost involved. Any collision with a dot resulted in a loud (unpleasant) noise, flashing of the entire TV screen and an immediate loss of 100 points. The same loss occurred during all subsequent collisions. Avoiding the collision by reversing direction in the face of an oncoming dot would also avoid the loss of 100 points. Moving through blank spaces to avoid collisions would result in minor losses of points which, however, stood in no proportion to the points lost because of a collision. In addition, the noise and flashing screen would not be presented.

Risky behavior in approaching an oncoming dot as far as possible before reversing could be explained by: (1) the hope that the dot would reverse direction (which it did occasionally on a random frequency basis), and (2) the desire to avoid the minor losses associated with moving through blank spaces. In other words, some incentive did exist to get as close as possible to an oncoming dot before reversing direction.

Risk taking scores were obtained by measuring the distance in the matrix between the subject's scoop and oncoming dots at the time the subject reversed direction. Distance was obtained in movement units (see the description of the task above). A measure of one, for example, would mean that a collision would have occurred during the next motion instant of the game. In other words, a lower score, for the present purpose, implies greater risk taking.* Risk scores during any one playing period were averaged to obtain mean risk scores.

Measurement of Physiological Response

Physiological response measures of heart rate, systolic blood pressure and diastolic blood pressure were obtained at rest, at the beginning of each playing period and in two-minute intervals thereafter as long as any playing period lasted (until the subject had scooped up all the squares in the matrix). Data were collected with the use of a Vitastat dual automatic monitor which repeatedly inflated a cuff placed on the non-dominant arm of each subject. Raw data were recorded by a printer. The raw data were averaged for each playing period and delta values (changes of blood pressure and heart rate values from resting base line) were calculated. For purposes of this research, delta values were used as the unit of analysis.

RESULTS AND DISCUSSION

This section will be concerned initially with the effect of the four load levels (two, four, six or eight dots on the screen) on risk taking *per se*. Subsequently, it will explore the relationship between these two variables and physiological response on one side and performance on the other.

---

*Reversal of direction at risk level 1 (one movement unit apart) would necessarily result in a collision if the dot pursued the subject's scoop to the next turn. A score of zero implied an immediate collision. With a reversal at a risk score two, a collision often (but not necessarily) occurred. Reversals at levels beyond a risk score of three made a subsequent collision less and less likely.

Load and Risk Taking

The effects of load on risk taking were analyzed with a one-way (four levels, within) Analysis of Variance. The obtained F ratio of 5.567 (3,72 df) is significant ($p < .002$). The data are presented in graphic form in Figure 2. Risk taking increased (toward a lower score, i.e., greater proximity to the threatening dot) as load levels became higher. The mean risk scores obtained indicate that subjects tended to be somewhat risky even when load levels were relatively low. A mean risk score (for load level 2) of 1.172 and risk levels below 1.0 for all other loads certainly indicate that the subjects, on the average, did endanger their scoop and were likely to have lost 100 points if the opposing dot followed to the next intersection of the matrix. Risk taking at a load level of 8 (Score .377) suggests that collisions with the dot occurred very frequently.

Comparison of obtained risk levels for the four load levels shows that the increase in riskiness with increasing load was gradual and stepwise. While not all comparison between adjacent load levels were significant or highly significant, p values for comparisons between once-removed load levels (load 2 vs. load 6: $p = .028$; load 4 vs. load 8: $p = .037$) and for the distant load comparison (load 2 vs. load 8: $p = .002$) certainly reflect increases in riskiness. The greatest single increase in risk taking occurred between loads 6 and 8 where a p value of .011 was obtained. The data show that overload produces more risk taking. As Streufert and Streufert (1982) have shown, increases in load for this task tend to reduce strategic efforts, i.e., reduce dimensionality of behavior. The remaining, more unidimensional, focus of the subjects appears to be on "cleaning up" the matrix by removing as many of the squares as possible (as instructed). Such a focus can and did lead to

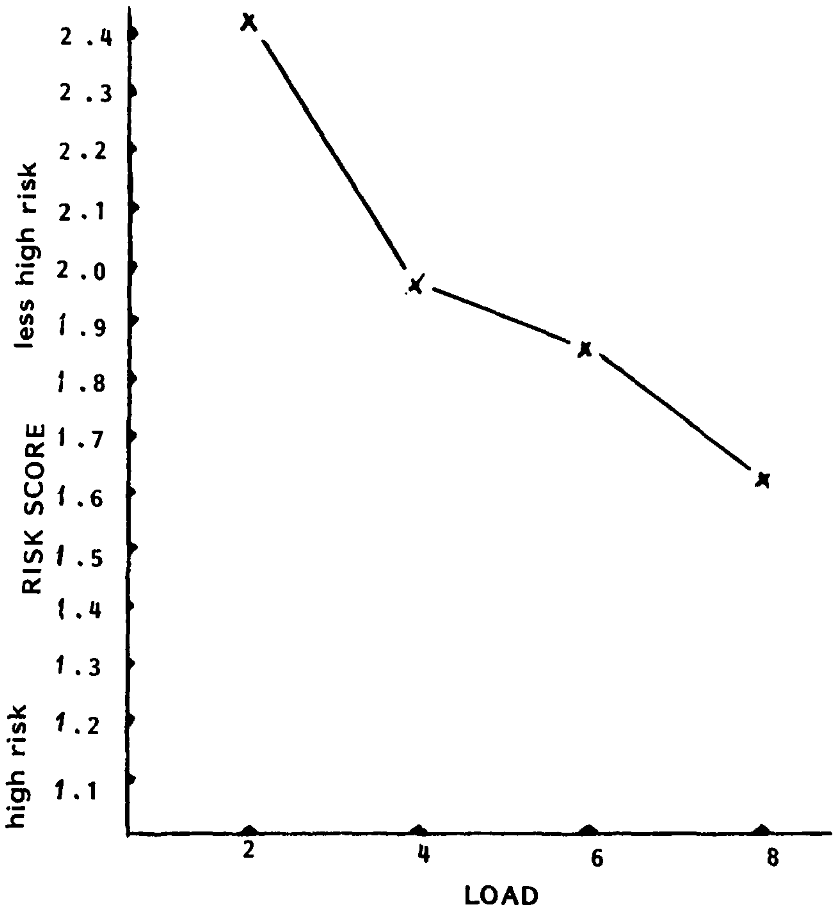

FIG. 2. EFFECTS OF LOAD ON RISK TAKING

greater risk taking orientation, even though negative reinforcement for colliding with dots was immediate and considerable.

Risk Taking and Performance

Streufert and Streufert (1982), utilizing the same task, have investigated the effects of load on performance. Their data show that performance scores (five points for each square erased from the screen minus one point for each empty space traversed, and potentially minus n times 100 points where n is the number of collisions with dots) decrease in near linear fashion with load, resulting in negative total scores (due to an inordinate number of collisions with dots) for loads 6 and 8. The decrease in performance obtained in that research parallels the findings of load effects on increasing risk taking obtained here. In other words, risk taking increases as performance decreases with increasing load levels.

Load, Physiological Responsivity and Risk Taking

At present, the physiological mechanisms involved in the translation of stressors into physiological strain and, potentially into behavioral change are insufficiently understood. Consequently, causal relationships leading from stressor to strain to behavior cannot be established with any degree of uncertainty. Nonetheless, we may be able to reach tentative conclusions about the relationship among these variables. It would be of interest to determine whether participation in the task is associated with physiological arousal, and whether increasing load in the task is associated with increased risk taking and heightened arousal. The argument that (often undesirable) changes in task performance which may be associated with risk are induced by experienced stress could not be supported if environmental stressors are translated into risk taking and associated performance changes without increased physiological arousal (i.e., without the "strain" which is experienced as stress). Without arousal, any behavioral modification due to changes in environmental stressor levels could simply be explained as a cognitive* "malfunction" which may have occurred, for example, due to excessive work load. To assess the degree to which stressors (here load) are associated with both risk/performance changes and with physiological arousal, changes in blood pressure during task performance will be considered in this paper.

Previous research (Streufert, Streufert, Lewis, Henderson and Shields, 1982) has shown that physiological strain for the kind of task employed in this research is best demonstrated by measurement of diastolic blood pressure (possibly affected by peripheral constriction).

Consequently, changes in diastolic blood pressure will be emphasized (even though systolic changes and heart rate elevations will be reported as well).

Physiological arousal may be evident in response to two stressor conditions which should be viewed separately: (1) participation in the task *per se*, irrelevant of the momentary difficulty or stressor level of the task, and (2) experience of the current difficulty (here load) level of the present task condition. In addition, the question of individual differences in response to the task and the task load levels may be raised.

---

*While it is understood that no simple distinction between "cold" cognition and "warm" (arousal associated) affect can be made, we will utilize that potential distinction for the purpose of the present paper.

There is no question that average diastolic blood pressure levels were raised above baseline during participation in the task ($F=5.006$, 4/96 df, $p < .001$) with a mean diastolic blood pressure elevation of 5.57 mm Hg. Similar discrepancies between baseline and task performance values were obtained for systolic blood pressure and for heart rate. In other words, participation in the task produced some degree of arousal. If the task itself is arousing, one might expect increasing levels of arousal with increasing load levels (parallel to the increases in risk taking and decreases in performance quality). Further, one might expect that with increasing load, risk taking might be increasingly associated (correlated) with arousal. While the means for delta diastolic blood pressure show <u>some</u> increase with load, and while the levels of correlations between risk taking and delta diastolic blood pressure do increase with load, those relationships are far from significant. Significance was not obtained for delta systolic blood pressure and delta heart rate either. In some part, the lack of significance could be explained by variability. Yet the obtained trends are too small to consider such an argument to be of much importance. Absence of significance may also be explained with assumptions which would argue: (1) that either the arousal levels of the task performance <u>per se</u> were sufficiently large to mask any (additional) effect of load, or (2) that load stress variation does not produce sufficient physiological strain to become evident in measurement of blood pressure and/or heart rate values. Let us explore each of these suggestions in turn.

The view that elevations of physiological responsivity (arousal) have reached a ceiling due to participation in the task <u>per se</u> does not appear to be persuasive. Other researchers (e.g., Dembroski and associates), utilizing challenge instructions, have obtained higher elevations in blood pressure during task performance than those recorded in this research. The second suggestion may be more persuasive, although it does not necessarily match the frequently noted verbal responses of participants during high load levels. Subject's exclamations often, but especially when load levels were high, appeared to reflect some degree of aggravation or upset. One may wonder whether such verbal exclamations are merely a reflection of habitual cognitive response negativity rather than a relfection of physiological arousal. A view of subjects' responses to a scale which had to be completed at the end of each playing period might aid us in reaching a conclusion. Subjects were asked to indicate on a seven-point scale how enjoyable the game they just played had been. The end points were marked "very enjoyable" and "not at all enjoyable." With a score of 1.0 reflecting a response of "not at all enjoyable" and a score of 7.0 reflecting a response of "very enjoyable," the values for the means of each playing period were:

PERIOD:	LOAD 2	LOAD 4	LOAD 6	LOAD 8
Value obtained:	5.75	5.95	5.83	5.71

Clearly, all periods of play were not only "enjoyable" as far as the subjects were concerned, but were, in addition, quite similar in the degree to which they were enjoyed. The probability of much negative affect, which would have likely produced considerable differences in physiological arousal among the periods of play can consequently be excluded. The data then appear to suggest that load effects on both risk taking and on performance are cognitively rather than affectively mediated (always allowing for a degree of artificiality in that distinction). Load as a stressor, at least in the present task, appears to have produced performance effects, but did not result in physiological "strain" or experienced "stress" to any major degree.

Individual Differences in Risk and Arousal

Risk taking scores for the four periods of play are positively correlated ($r = .159$ for load levels 2 and 4, $r = .241$ for levels 2 and 6, $r = .337$ for levels 2 and 8, $r = .599$ for levels 4 and 6, $4 = .427$ for levels 4 and 8, and $r = .609$ for load levels 6 and 8), suggesting that individuals were relatively consistent in their tendency to be either more or less risky.

Consistency across periods in risk taking proclivity may suggest differences which might be reflected in physiological responsivity. To check on a potential relationship of this nature, a median split analysis (dividing subjects into below and above mean delta diastolic blood pressure individuals, $n=12$ in each group) for obtained risk scores was carried out. Persons with lower arousal during the game engaged in less risk taking ($F = 5.642$, 1/22 df, $p < .025$). The F ratio for load was highly significant (see above). The interaction term of load and blood pressure differences ($F = 1.944$, 3/66 df, $p < .15$) failed to reach significance. (Median split analysis for systolic blood pressure and heart rate were, as expected, not significant). It appears reasonable to conclude that diastolic arousal as an individual difference variable is to some degree associated with risk taking which, in turn, is strongly associated with performance quality.

Conclusions

The data have shown that participation in the present task is associated with some degree of arousal, that persons with greater degrees of diastolic arousal tend to take greater risks, but that load levels fail to relate to arousal. On the other hand, load is related to risk taking and to performance outcome. Both load and arousal appear to have some relationship to risk taking, but, at least for the research design and/or the task employed here, these associations appear to be independent of each other.

Whether and under what (time, challenge, task, etc.) stressor conditions a relationship among all three variables might exist remains in question. Based on the present research, it appears that risk taking and subsequent performance decrement outcomes under conditions of environmentally induced stressors may (at least in some cases) be an effect of purely cognitive overload. Again, based on the present research, risk taking does not appear to be produced by load-stressor-induced physiological strain or by a potential interaction of cognitive overload and strain effects. On the other hand, there appear to be relationships between systolic arousal and risk taking, at least in the form of individual differences. It is, of course, possible that the task and the instructions used in this research had specific effects that might have modified subjects' responses. For example, to the degree to which the subjects viewed the task as a game in the normal sense, they might have resorted to response tendencies and/or strategies that could have influenced the perceived level of challenge, stress, etc. and in turn might have modified a strain response irrelevant of the load employed. While this explanation of the lack of load effects on physiological response appears unlikely, it deserves consideration in future research efforts.

Future research should investigate the stress-strain-risk taking/ performance relationship in the context of a number of additional task settings, under diverse instructions, etc., to determine the generality vs. specificity of the data obtained in the present effort. The research program of which this research is a part will in the future explore the load-risk taking-arousal relationship in a complex simulation setting which will introduce participation of greater length and a task setting which produces greater involvement for the participant. Such a setting will provide an ideal check for the generality and applicability of the present findings to other settings.

REFERENCES

Barth, J. L., Holding, D. H. and Stamford, B. A. Risk versus effort in the assessment of motor fatigue. Journal of Motor Behavior, 1976, 8, 189-194.

Ben-Zur, H. and Breznitz, S. J. The effect of time pressure on risky choice behavior. Acta Psychologica, 1981, 47, 89-104.

Coombs, C. H., Donnel, M. L. and Kirk, D. B. An experimental study of risk preference in lotteries. Journal of Experimental Psychology: Human Perception and Performance, 1978, 4, 497-512.

Dembroski, T. M., MacDougall, J. M., Shields, J. L., Petitto, J. and Lushene, R. Components of the Type A coronary prone behavior pattern and cardiovascular responses to psychomotor performance challenge. Journal of Behavioral Medicine, 1978, 1, 159-176.

Dickson, J. W. Perception of risk as related to choice in a two-dimensional risk situation. Psychological Reports, 1978, 43, 1059-1062.

Fromkin, H. L. and Streufert, S. Laboratory experimentation. In M. Dunnette (Ed.), Handbook of Organizational and Industrial Psychology. Chicago: Rand McNally, 1976.

Glass, D. C., Krakoff, L. R., Finkelman, B. S., Snow, B., Contrada, R., Kehoe, K., Mannucci, E. G., Isecke, W., Collins, C., Hilton, W. F. and Elting, E. Effects of task overload upon cardiovascular and plasma catecholamine responses in Type A and B individuals. Basic and Applied Social Psychology, 1980, 1, 199-218.

Jellison, J. M. and Riskind, J. Attribution of ability to others on skill and chance tasks as a function of level of risk. Journal of Personality and Social Psychology, 1972, 22, 135-138.

Johansson, G., Aronsson, G. and Lindstrom, B. O. Social psychology and neuroendocrine stress reactions in highly mechanized work. Ergonomics, 1978, 21, 583-599.

Jones, E. E. and Johnson, C. A. Delay of consequences and the riskiness of decisions. Journal of Personality, 1973, 41, 613-637.

Lamm, H., Myers, D. G. and Ochsmann, R. On predicting group-induced shifts towards risk or caution: A second look at some experiments. Psychologische Beitrage, 1976, 18, 288-296.

Lehner, P. E. A comparison of portfolio theory and weighted utility models of risky decision making. Organizational Behavior and Human Performance, 1980, 26, 238-249.

Lupfer, M. and Jones, M. Risk taking as a function of skill and chance orientations. Psychological Reports, 1971, 28, 27-33.

Mackova, Z. Subjective probability in decision making. Studia Psychologica, 1979, 21, 187-195.

Milburn, T. W. and Billings, R. S. Decision-making perspectives from psychology: Dealing with risk and uncertainty. American Behavioral Scientist, 1976, 20, 111-126.

Patkai, P. Catecholamine excretion in pleasant and unpleasant situations. Acta Psychologica, 1971, 35, 352-363.

Payne, J. W. Alternative approaches to decision making under risk: Moments versus risk dimensions. Psychological Bulletin, 1973, 80, 439-453.

Pruitt, D. G. Choice shifts in group discussion: An introductory review. Journal of Personality and Social Psychology, 1971, 20, 339-360.

Pruitt, D. G. Conclusions: Toward an understanding of choice shifts in group discussion. Journal of Personality and Social Psychology, 1971, 20, 495-510.

Roscoe, A. H. Stress and workload in pilots. Aviation, Space and Environmental Medicine, 1978, 49, 630-636.

Roth, N., Guhlmann, B. and Girbardt, M. The relationship between performance and activation under the influence of internal and external factors. Zeitschrift fur Psychologie, 1976, 184, 570-583.

Schoemaker, P. J. The role of statistical knowledge in gambling decisions: Movement vs. risk dimension approaches. Organizational Behavior and Human Performance, 1979, 24, 1-17.

Staw, B. M. Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. Organizational Behavior and Human Performance, 1976, 16, 27-44.

Streufert, S. Complexity and complex decision making: Convergences between differentiation and integration approaches to the prediction of task performance. Journal of Experimental Social Psychology, 1970, 6, 494-509.

Streufert, S., Castore, C. H., Nogami, G. Y. and Streufert, S. C. Literaturrecherche zum gegenwartigen Stand der Forschung auf dem Gebiet des Risikoverhaltens mannlicher Jugendlicher mit spezieller Beziehung auf die Streitkrafte. Wehrpsychologische Unversuchungen, entire issue No. 3, 1979.

Streufert, S., Driver, M. J. and Haun, K. W. Components of response rate in complex decision making. Journal of Experimental Social Psychology, 1967, 3, 286-295.

Streufert, S. and Streufert, S. C. Effects of increasing failure and success on military and economic risk taking. Journal of Applied Psychology, 1970, 54, 393-400.

Streufert, S. and Streufert, S. C. Effects of load stressors on performance in a multidimensional visual-motor task. The Pennsylvania State University College of Medicine: ONR Technical Report No. 6, 1982.

Streufert, S., Streufert, S. C., Lewis, J., Henderson, R. and Shields, J. L. Differential effects of four stressors on blood pressure and heart rate. The Pennsylvania State University College of Medicine: ONR Technical Report No. 5, 1982.

Tversky, A. and Kahneman, D. The framing of decisions and the psychology of choice. Science, 1981, 211, 453-458.

Vlek, C. and Stallen, P. J. Rational and personal aspects of risk. Acta Psychologica, 1980, 45, 273-300.

Woo, T. and Castore, C. H. Expectancy-value and selective exposure as determinants of attitudes toward a nuclear power plant. Journal of Applied Social Psychology, 1980, 10, 224-234.